

Electrical Circuits (2)

Sheet 2 – Natural and Step Response of an RL - RC Circuit

- 1) The switch in the circuit in Fig. 1 has been in position 1 for a long time. At $t = 0$, the switch moves instantaneously to position 2. Find $v_0(t)$ for $t \geq 0^+$.

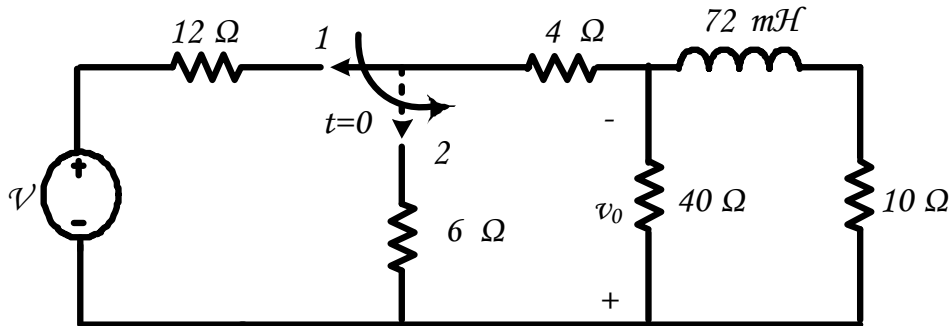


Fig. 1

- 2) In the circuit in Fig 2: the voltage and current expressions are

$$v = 72e^{-500t}V, t \geq 0, \quad i = 9e^{-500t}mA, t \geq 0^+$$

Find:

- R.
- C.
- The time constant of the circuit (in milliseconds)
- The initial energy stored in the capacitor.
- The time (in milliseconds) it takes to dissipate 68% of the initial stored energy.

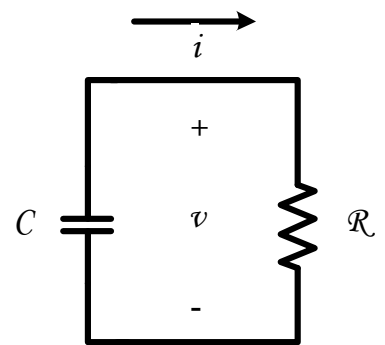


Fig. 2

- 3) The switch in the circuit in Fig. 3 is closed at $t = 0$ after being open for a long time.

- Find $i_1(0^-)$ and $i_2(0^-)$
- Find $i_1(0^+)$ and $i_2(0^+)$
- Find $i_1(t)$ for $t \geq 0$.
- Find $i_2(t)$ for $t \geq 0^+$.
- Explain why $i_2(0^-) \neq i_2(0^+)$
- Explain why $i_1(0^-) = i_1(0^+)$

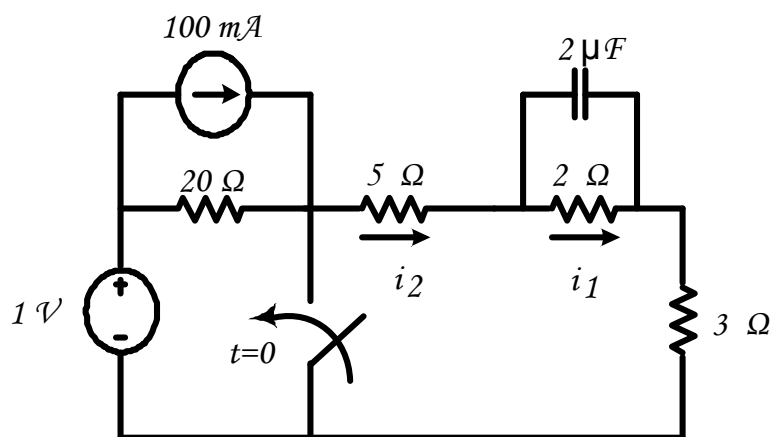
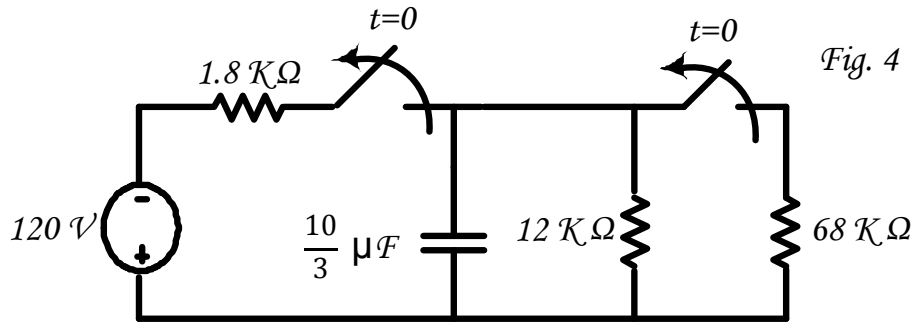


Fig. 3

4) In the circuit shown in Fig. 4, both switches operate together; that is, they either open or close at the same time. The switches are closed a long time before opening at $t = 0$.

a) How many microjoules of energy have been dissipated in the $12\text{ k}\Omega$ resistor 12 ms after the switches open?

b) How long does it take to dissipate 75% of the initially stored energy?



5) The switch in the circuit shown in Fig. 5 has been closed for a long time before opening at $t = 0$.

a) Find the numerical expressions for $i_L(t)$ and $v_o(t)$ for $t \geq 0$.

b) Find the numerical values of $v_L(0^+)$ and $v_o(0^+)$.

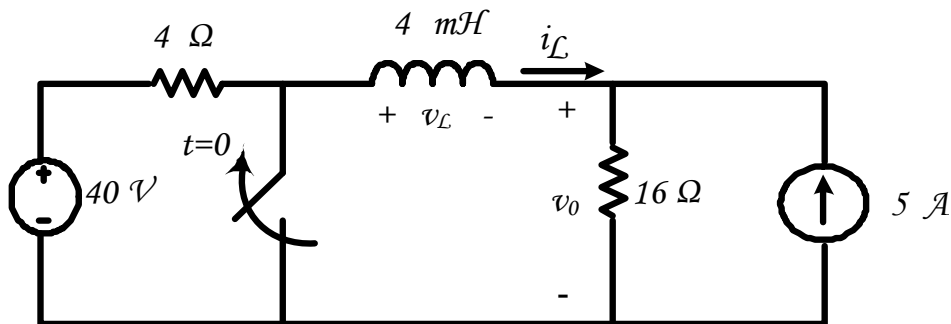
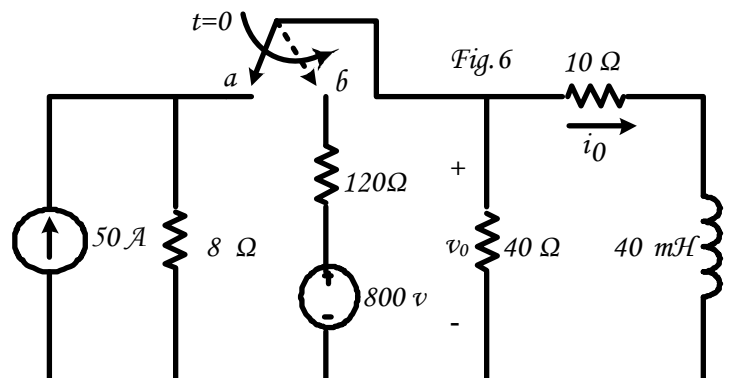


Fig.5

6) The switch in the circuit shown in Fig. 6 has been in position (a) for a long time. At $t = 0$, the switch moves instantaneously to position b.

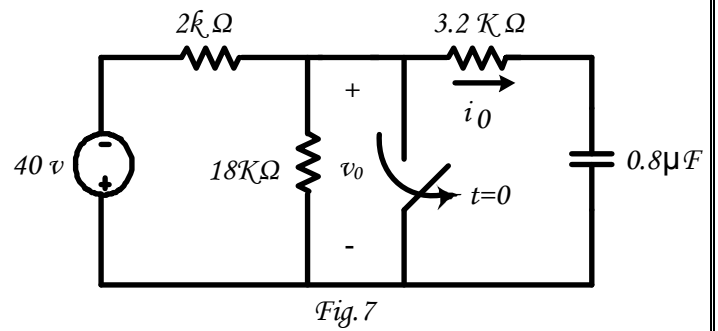
a) Find the numerical expression for $i_o(t)$ when $t \geq 0$.

b) Find the numerical expression for $v_o(t)$ for $t \geq 0^+$.



7) The switch in the circuit shown in Fig. 7 has been closed a long time before opening at $t = 0$.

- What is the initial value of $i_0(t)$?
- What is the final value of $i_0(t)$?
- What is the time constant of the circuit for $t \geq 0$?
- What is the numerical expression for $i_0(t)$ when $t \geq 0^+$?
- What is the numerical expression for $v_0(t)$ when $t \geq 0^+$?



8) Assume that the switch in the circuit of Fig. 8 has been in position (a) for a long time and that at $t = 0$ it is moved to position (b).

Find:

- $v_c(0^+)$.
- $v_c(\infty)$.
- The time constant of the circuit for $t \geq 0^+$.
- $i(0^+)$.
- $v_c(t)$ When $t \geq 0$.
- $i(t)$ when $t \geq 0^+$.

